HANDY FORMULAS
EVERY ENGINEER SHOULD KNOW

Update: 3/9/06

WATER

$$\text{TONS} = \frac{\text{GPM} \times \text{CHILLED WATER RANGE}}{24}$$

$$24 = \frac{200 \text{ BTU/MIN}}{(8.33\#/\text{GAL.}) \times (1.0 \text{ SPECIFIC HEAT}) \times (1.0 \text{ SPECIFIC GRAVITY})}$$

$$\text{EER} = \frac{\text{MBH NET}}{\text{KW TOTAL}} = \frac{\text{TONS} \times 12}{\text{KW}}$$

$$\text{COND. GPM} = \frac{\text{TONS} \times 30}{\text{COND. WATER RANGE}}$$

$$\text{PUMP BHP} = \frac{\text{GPM} \times \text{TOTAL SYSTEM HEAD (FT. } H_2O)}{3960 \times \text{PUMP EFFICIENCY}}$$

$$\text{POWER} = \frac{\text{LOAD} \times \text{HEAD}}{\text{EFFICIENCY}}$$

$$\text{GPM WATER} = \frac{\text{TOTAL COOLING LOAD (MBH)} \times 2}{\text{WATER TEMPERATURE RISE}}$$

$$\text{WATER PRESSURE DROP (FT)} = 2.31 \times \triangle \text{ PSIG}$$

AIR

$$\text{TOTAL COOLING LOAD (MBH)} = 4.5 \times \text{CFM STANDARD AIR} \times (\text{ENTHALPY ENT. AIR -- ENTHALPY LVG. AIR}) / 1000$$

$$\text{SENSIBLE COOLING LOAD (MBH)} = 1.08 \times \text{CFM STANDARD AIR} \times \frac{(\text{EDB-LDB})}{1000}$$

TOTAL COOLING LOAD : BTU/HR. = GPM x 500 x (EWT-LWT)

$$4.5 = 0.075 \text{ (WT. OF STD. AIR, \# / FT}^3\text{)} \times 60 \text{ (MIN./HR.)}$$

$$1.08 = 0.075 \text{ (WT. OF STD. AIR, \# / FT}^3\text{)} \times 60 \text{ (MIN./HR.)} \times 24 \text{ (Specific Heat of dry air)}$$

$$500 = 8.33 \text{ (WT. OF } H_20 \text{ @ 60 degF, \# / GAL)} \times 60 \text{ (MIN./HR.)} \times 1.0 \text{ (Specific heat of water)}$$

TOTAL PRESSURE = VELOCITY pressure (Vp) + STATIC pressure (Sp)

CFM = face velocity (ft/min) / face area (sq. ft) = face area x 4005 x sqrt(Vp/k)

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ELECTRICAL

PUMP KW = $\frac{\text{FLOW (gpm) x PD (ft)}}{\text{5311 x Epump x Emotor}}$

PUMP HP = $\frac{\text{FLOW (gpm) x HEAD (ft)}}{\text{5311 x Epump x Emotor}}$

FAN KW = $\frac{\text{.7457 x BHP}}{\text{Emotor}}$

FAN HP = $\frac{\text{CFM x SP}}{\text{6350 x Efan}}$

1.73 = $\sqrt{3}$ FOR THREE PHASE SERVICE

FAN STATIC EFF = $\frac{\text{CFM x SP}}{\text{6350 x BHP}}$

BTU = KW x 3415
1KW = 1.34 HP
1 HP = 2545 BTUH

BASIC FAN LAWS

$$\frac{CFM_1}{CFM_2} = \frac{RPM_1}{RPM_2}$$

$$\frac{SP_1}{SP_2} = \frac{(RPM_1)^2}{(RPM_2)^2} = \frac{(CFM_1)^2}{(CFM_2)^2}$$

$$\frac{BHP_1}{BHP_2} = \frac{(RPM_1)^3}{(RPM_2)^3} = \frac{(CFM_1)^3}{(CFM_2)^3}$$

DRIVE CALCULATIONS

MOTOR RPM x MOTOR PULLEY PD = BLOWER RPM x BLOWER PULLEY PD

$\frac{1{,}750 \times 7.2}{10.6}$ = 1,190 BLOWER RPM

10% TOO MUCH CFM:

$\frac{1{,}750 \times 7.2}{1{,}190 \times (0.90)}$ = 11.8 " PD BLOWER PULLEY